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ANALYSIS OF THE PROPAGATION VELOCITY MEASURED IN CRITICAL DIAMETER TESTS OF CLASS 1.3 COMPOSITE PROPELLANTS

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We performed a series of tests on cylinders of several similar Class 1.3 composite propellants made of Ammonium Perchlorate (AP), Aluminum, and a plastic binder, in Critical Diameter (CD) test geometry with diameters between 16 and 60 inches. In those tests, the cylinders were 2.5 to 4 diameters long. The AP booster was the same diameter as the propellant and between 0.5 and 2 diameters long. Experimental results for various similar propellants, including propagation velocity at locations more than 2 diameters downstream of the AP/propellant interface were reported at the previous two meetings of this subcommittee. For all propellants from 0.4 to 0.9m diameter, the propagation velocity measured at two diameters downstream was less than 2.6 km/s, which corresponds to a pressure less than 10 kbar.

We performed computer simulations of these CD tests using CALE, and calibrated parameters in our ignition and growth model, which describes the decomposition and energy release of these propellants under shock stimulus. We used two extreme and contrasting models for the growth of reaction that correspond to (a) hot-spots burning outward, and (b) small grains burning inward from their surface. Although the behavior of these two models is quite different, either can be used to describe the response of all propellants in all CD geometries from 0.4 to 0.9m diameter. We used both models to predict the response of the Titan SRMU propellant at 1.5m diameter (Summer 1996). The two models predict quite different response: the hot-spot model predicts a 200 kbar detonation; the grain-burning model predicts sustained propagation of a 20 kbar shock. We use the results of the 1.5m test to define a single ignition and growth model that describes the propagation velocity for all propellants in all CD tests.

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